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Bloodborne Pathogens in Aircraft Accident Investigation

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16. Abstract The Occupational Safety and Health Administration (OSHA) amended 29 CFR Part 1910 in 1991 to include regulations addressing occupational exposure to bloodborne pathogens (BBP). The rule affects all employees who have the potential for occupational exposure to these pathogens. An accident scene presents significant challenges in terms of implementing a program which was primarily envisioned to affect personnel in "traditional" healthcare delivery facilities; the OSHA requirements now had to be met in the chaotic, inhospitable, and logistically difficult environment of an aircraft accident site. Unanticipated issues, such as heat-related conditions, performance of physically demanding work in cumbersome gear, biohazard trash disposal from remote sites, and a host of other problems had to be dealt with. The Federal Aviation Administration (FAA), in close cooperation with other Federal agencies, developed a training and administrative program to meet the requirements of the OSHA BBP rule as it relates to the unique environment of an aircraft accident site. The program has been implemented and successfully tested under actual field conditions at the sites of several major aviation accidents that have occurred recently. This article provides observations on the FAA's program and lessons learned from its implementation.					
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BLOODBORNE PATHOGENS IN AIRCRAFT ACCIDENT INVESTIGATION

BACKGROUND

In 1991, the Occupational Safety and Health Administration (OSHA) issued the Regulations for Engineering Control, Title 29 of the Code of Federal Regulations, Part 1910.1030 (29 CFR, Part 1910.1030), which amended part 1910 by providing the requirements and guidance to prevent employee occupational exposure to bloodborne pathogens (BBP). The regulation applied to all occupational exposure to blood or other biological material that presented a potential risk for infection. The regulation defined *occupational exposure* as "reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties"(1). OSHA further defined these *infectious materials* as "...semen, vaginal secretions, cerebrospinal fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids..."(1) This last item would certainly categorize what frequently happens at aviation accident sites where total disruption of the aircraft hull has occurred, resulting in major trauma to the occupants.

In 1995, the Federal government reported that 2,352 civilian fixed-wing aircraft and rotorcraft accidents occurred; these accidents resulted in 969 fatalities.(2) These represent air transport, commercial, and general aviation accidents. Preliminary numbers for 1996 reflect 2,040 aviation-related accidents, 390 of which were fatal with 1,070 victims.(3) 1996 appears to be the second highest year for people killed in airline accidents since the NTSB revised its statistical analysis in 1982.(4) Although the National Transportation Safety Board (NTSB) has the ultimate responsibility of determining the cause of civil aircraft accidents in the United States, Federal Aviation Ad-

ministration (FAA) personnel work closely with the NTSB in all phases of the investigation of these accidents. In some aircraft accidents, the NTSB may request that the FAA conduct the investigation and submit a factual report to be used by the Board in determining probable cause. As a regulatory agency, the FAA also has a statutory obligation to investigate aircraft accidents to determine compliance with established federal aviation regulations. Typically, this process is done in conjunction with the NTSB investigation, although in some instances it may occur separate and apart.

The FAA's role in aircraft accident investigation created the need to formulate a program for bloodborne pathogens' exposure prevention that complied fully with 29 CFR, Part 1910.1030. Although FAA accident investigators *per se* are not tasked with the removal of victims from aircraft accident sites, the subsequent on-site investigations they conduct places them at potential risk for BBP contamination. Jagged pieces of metal covered with tissues and body fluids present additional hazards to the already dangerous environment tainted in many cases by chemicals and products of combustion from fuels, oil, hydraulic fluid, aircraft components, and interior furnishings. The amounts of tissues and body fluids present may vary considerably from accident to accident. Survivable accidents may have little or no contamination, whereas those which occurred with the aircraft impacting at high rate of speed or in an unusual attitude may involve significant fragmentation of the aircraft hull and its occupants, with subsequent widespread dissemination of potentially infectious biological contaminants. However, the lack of major trauma or fragmentation of bodies does not make the accident site any less of a hazard for accident investigators, from the standpoint of potential bloodborne pathogens transmission. An example of this was the September 5, 1996, in-flight fire of a commercial DC-10 aircraft, whose cargo manifest included small quantities

of medical radioactive materials and HIV-positive blood.(5) No loss of life occurred in this case, but the cargo could have presented a BBP risk in the subsequent investigation. While a post-crash fire may decontaminate biological hazards, this should not be interpreted as a reason for investigators to dispense with the concept of universal precautions for biological contaminants in areas where obvious burning has occurred.

While the language of the BBP regulation was primarily directed at the environment of medical treatment facilities and other activities directly involved in the provision of medical services to individuals, it quickly became evident that non-healthcare activities needed to also comply with the provisions. The investigation of aircraft accidents provided a unique set of circumstances that clearly needed to meet the provisions of the OSHA BBP regulation, yet the guidelines set forth in Part 1910.1030 created significant logistical problems in implementation. An aircraft accident site does not compare in any way to the well-structured environment of a hospital or medical office; therefore, applying Part 1910.1030 to a chaotic and usually isolated site presented a unique dilemma with no clear precedent to build on. The healthcare industry had been conducting infection control and prevention for years prior to the advent of the OSHA BBP rule; therefore, providers were well versed in the dangers of disease transmission. Aircraft accident investigators, on the other hand, were not. Investigators consist primarily of non-medical personnel, well trained in technical and engineering aspects of aircraft, but unfamiliar with the nuances of infection control. The FAA was confronted with creating a program to teach the essentials of infection control to non-medical employees, and provide all of the necessary personal protective equipment, handwashing facilities, engineering controls, infectious trash disposal, and other BBP functions of a fixed healthcare facility at an inhospitable and often remote site.

This dilemma affected all organizations involved in aircraft accident investigation. These include Federal and local government officials, police, firefighters, ambulance personnel, medical examiner office staff, aircraft and engine manufacturers, insurance adjusters, labor representatives, and a host of other indi-

viduals needing direct access to the accident site. Given this circumstance, the FAA and NTSB worked together to jointly train their investigators and educate others involved in the investigation, on the appropriate infection control precautions to take at the accident site. The combined expertise of the FAA and NTSB in different facets of aircraft accident investigation complemented the process.

Additionally, while at the accident site, the FAA and NTSB oversee the activities of companies (e.g., aircraft and engine manufacturers, avionics equipment manufacturers, insurance adjusters) and other entities (e.g., labor groups) who are parties to an aircraft accident investigation. These companies and entities may be directly responsible for providing training and personal protective equipment to their respective employees and for complying with all provisions of the BBP rule. The NTSB and other government agencies may deny access to an aircraft accident site to anyone who is not in compliance with the provisions of the BBP rule. The NTSB has the added responsibility and jurisdiction to investigate the cause of a variety of other transportation accidents (railway, maritime, and highway), where BBP protection would also be an issue.

FAA BLOODBORNE PATHOGENS PROGRAM

Prior to 29 CFR 1910.1030, the Federal government, including the military, had no comprehensive program in place that addressed and mitigated the potential for disease transmission at an aircraft accident site. Infection control was at best a piecemeal effort, usually undertaken by individuals based on their degree of knowledge or interest concerning the subject and personal experience in accident investigation. Because there was no program that required all accident investigators to be formally trained concerning infection control and be adequately protected, the FAA had to develop a program for its investigators that comprehensively addressed the issue. The first step in the complicated process was the creation of FAA Order 8020.14, which established the agency's Accident Investigation Bloodborne Pathogens Exposure Control Program.(6) The Order was developed

to provide specific guidance concerning 29 CFR Part 1910.1030. It named the FAA organizations responsible for implementation and funding of the mandates contained within the Order, listed the necessary procedures, paperwork, reporting requirements, and specified the employee's responsibility for compliance.

Overall FAA accident investigation oversight is assigned to the Office of Accident Investigation (AAI) in Washington, D.C. Several other organizations play specialized key roles in accident investigation; these include the Office of Aviation Medicine (AAM), the Aircraft Certification Service, the Flight Standards Service (FSS), the Aircraft Certification Directorate, the Research Directorate for Aviation Safety, the Office of Aviation Security, and the FAA's William J. Hughes Technical Center. These organizations became components in the development and implementation of the agency's overall exposure control plan. The FSS was assigned the lead role in creating the required program because their inspectors are the ones primarily tasked with accident investigation. The Office of Aviation Medicine had the role of providing medical expertise in the development and implementation of the FAA's BBP program.

Aviation Safety Inspectors (ASIs) assigned to the various FSS Flight Standards District Offices (FSDOs) across the United States play a crucial role at the accident site, and do so almost from the beginning of the investigation. The FAA has approximately 2,100 ASI who have collateral duties directly involving aircraft accident investigations. Although considerably less in numbers, some employees from the other previously mentioned FAA organizations also had to be brought into compliance with OSHA BBP requirements. Additionally, each FAA organization whose employees had direct on-site accident investigation responsibilities had to be trained on the issues and then tasked with creating individual exposure control plans that addressed the requirements of the BBP rule.

PROGRAM DEVELOPMENT

Development of the FAA's BBP program for aircraft accident investigators required strict adherence to OSHA's mandate but, as mentioned, with the appropriate modifications needed to fit very unique

situations and environments. The program that developed was multifaceted, covering basic information on bloodborne diseases, especially HIV/AIDS and hepatitis B, basic infection control measures, hepatitis B vaccination, the use of personal protective equipment (PPE), recordkeeping of exposure incidents and training, and a variety of other topics.

Training

FAA employees covered by the OSHA BBP rule had to be made aware of potential bloodborne diseases they might encounter at an accident site and on infection control procedures. Most of these investigators had no previous knowledge or formal training with any type of medical issues; therefore, a comprehensive training program was developed by the FAA in partnership with other organizations to provide the necessary information and skills.

The training program that evolved utilized lectures, question and answer sessions, handouts, and instructional video materials. The FAA Flight Standards Service, the Office of Aviation Medicine, and the Office of Accident Investigation jointly developed the training program. Program development assistance was solicited from the Professional Airways Systems Specialist (PASS) union, which is the bargaining unit for select Flight Standards Service employees. The NTSB was also invited to participate in the development of the training program and videos in order to facilitate joint utilization by both agencies of the materials and lectures developed.

The series of didactic lectures was designed to present specific information on OSHA's BBP rule and FAA administrative procedures, and to provide ample time for questions and answers on these issues. Teaching packets consisting of a course outline, copies of the actual rule, lecture scripts and overhead slides, copies of FAA Order 8020.14, a glossary of terms, and step-by-step administrative procedures with sample letters for required actions, were designed and assembled for the instructors. Additionally, handouts of copies of the Rule and general information on bloodborne pathogens were created for the students.

VHS format training videos were developed to cover a variety of topics including discussions of the Human Immunodeficiency Virus (HIV) and Acquired

Immune Deficiency Syndrome (AIDS) (7), hepatitis and the hepatitis B virus, hepatitis B vaccination, universal precautions, appropriate accident site behavior to avoid an exposure incident, and use of PPE. The videos developed at the FAA's Mike Monroney Aeronautical Center in Oklahoma City, were reproduced and disseminated within the FAA, NTSB, and to other organizations.

Once training program design was completed, a prototype training course was held in Oklahoma City. Flight Standards BBP program coordinators from all nine FAA regions, FAA medical personnel, NTSB, and union representatives participated in this "train-the-trainers" session. The presentations and videos were analyzed, and based on observations received, revisions were made to improve content and format. The session also provided time for "hands on" use of PPE; this allowed prospective trainers to experience, first-hand, the difficulties expected in donning and removing some of this equipment, including the coverall garments. It quickly became evident that, should use of the full protective suits become necessary, significant problems would be encountered with seasonal heat-related injuries; therefore, heat illness awareness training was added to the core curriculum. It was also determined that several suits would be required per inspector at any given site due to the operational requirements of the investigations and the OSHA regulations in force. Every time investigators entered and exited the contaminated site, they would have to don or dispose of some PPE. This action could have the potential to create a significant logistical problem, especially at remote sites, because a significant number of different size PPE would have to be stocked and transported to the accident site to meet the needs of the investigators. The information gathered at this initial training session produced significant changes in the training modules and caused a reassessment of the previously proposed use of PPE.

Following the completion of training module development, additional funding was made available for PPE purchases, large scale production of training materials, and implementation of training sessions at the various facilities. The required initial training of covered personnel commenced shortly thereafter.

Training sessions were conducted by Flight Standards Service regional personnel, in conjunction with FAA regional medical staff. The sessions were primarily geared for the various FAA employees involved in accident investigation; however, employees from the NTSB and other government agencies were invited to participate. Initial training of all 2,100 Flight Standards aircraft accident investigators covered by the BBP rule was completed. The program has now entered the phase of providing recurrent annual training and initial training for new hires. In addition, more than 400 other individuals have been trained; these primarily represent personnel from other FAA divisions and other Federal agencies or organizations.

Recordkeeping

To assist FAA field offices in developing the necessary program documentation, PC-based word processing templates of a typical exposure control plan and the necessary letters or forms were created. These were made available to FAA field office supervisors during the training program to ensure their understanding and compliance with OSHA mandates. These templates allowed supervisors the ability to customize necessary documentation by simply filling in the blanks or editing the text of the template. Field offices are responsible for maintaining OSHA BBP records on their employees. The only exception are medical records relating to the clinical evaluation of employees who have had an exposure incident; these records are maintained by the cognizant FAA regional medical office in accordance with OSHA guidelines.

Hepatitis Vaccination

Another key component of the OSHA requirements is the need to provide hepatitis B vaccination to those individuals who desire it. Training sessions dedicate approximately one hour towards HIV/AIDS and hepatitis awareness. These are the two diseases that OSHA stresses in 29 CFR 1910.1030; however, the importance of universal precautions for a wide spectrum of conditions was also emphasized during training. Included were comments on the increasing incidence and threat of hepatitis C, for which no vaccine currently exists. This portion of the training

was presented by FAA physicians, with the training content modified to suit the needs of the non-medical personnel to be trained.

The vaccination series with Engerix® or Recombivax® to protect against hepatitis B was discussed at length in an attempt to dispel any misconceptions or concerns about their safety or use. Efficacy of the vaccines and current Centers for Disease Control recommendations were also discussed, as was the use of hepatitis B immune globulin.(8) While the full three-injection series of vaccination was encouraged, participants were made fully aware of their ability to decline vaccination without adverse occupational consequences. The necessary consent/decline form completion procedures were reviewed.

An interesting phenomenon has been detected with hepatitis B testing of post-mortem tissue samples received for toxicological examination at the FAA's Civil Aeromedical Institute (CAMI) in Oklahoma City. For yet unexplained reasons, positive hepatitis B results were obtained in a series of 18 cases done at CAMI; however, review of medical records on the victims gave no indication of hepatitis.(9) Manufacturers of the hepatitis screening test using the EMIT/ELISA methodology were contacted; they were aware of potential false positive results in post-mortem samples but also had no clear explanation for the reasons. This problem precludes testing of post-mortem samples for hepatitis B as a means of reassuring accident investigators of the absence of this disease in a victim. Employees are notified of this fact during training. No similar false positive problem has been documented for Human Immunodeficiency Virus (HIV) detection.

A related vaccination issue is the recent approval of the first hepatitis A vaccine. This vaccine contains a sterile suspension of inactivated hepatitis A virus and is being marketed in the U. S. under the tradenames Vaqta® and Havrix® by Merck and Smith Kline Beecham Biologicals, respectively.(10,11) At the time this manuscript was being published, no official position had been taken by OSHA as to the requirement for use of this vaccine by personnel in occupations at risk for biological pathogen exposure.

FIELD EXPERIENCE AND LESSONS LEARNED

Since the inception of the FAA aircraft accident BBP program, Office of Aviation Medicine staff members have been involved in the investigation of numerous accidents requiring the use of BBP protection protocols and PPE. The first of these was the investigation of USAir flight 427, a Boeing-737 which crashed near Pittsburgh, Pennsylvania, in September 1994. This was followed by investigations of the October 1995 Roselawn, Indiana crash of an American Eagle ATR-72 and the April 1996 ValuJet flight 592, a DC-9, which crashed in the Florida Everglades northwest of Miami. Our ability to deal with the issues of bloodborne pathogens contamination at an accident site has improved dramatically and is in sharp contrast to the capabilities available during the 1972 Eastern Airlines L-1011 crash in the Florida Everglades eight miles north of the ValuJet crash. At that time, the NTSB and FAA (or, for that matter, any other government organization) had no formal biohazard program concerning accident investigations; the use of personal BBP protection equipment was haphazard at best, and the biohazard containment process for the accident site was nonexistent.

One of the authors (C.D.) participated in the field portion of the investigations in Pittsburgh and Roselawn and gathered significant experience in on-site biohazard protection and containment. Both of these accidents presented significant hazards for all those involved with the recovery efforts and challenged the fledgling FAA BBP program. Biohazard decontamination facilities with effective containment of waste water had to be constructed. The logistics capability of providing sufficient quantities of protective gowns, gloves, and goggles to allow multiple clothing changes for investigators, had to be developed. Ample drinking water and rest cycles had to be provided to cope with the additional dehydration and heat exhaustion that resulted from wearing the impermeable BBP protective gowns. The biological decontamination of aircraft parts had to be done quickly and in such a way that would not damage the parts or

affect possible clues that might help explain the cause of the accident. The lessons learned at these sites, provided for the smooth implementation of a bloodborne pathogens protection program at probably the most challenging aircraft accident site in years, the Florida Everglades. Providing BBP protection at the ValuJet site was a significant undertaking with logistical problems that exceeded issues encountered at other sites.

Another author (R.H.) was involved in the ValuJet accident. This accident presented investigators a truly unique site, not only from the standpoint of BBP, but also from an environmental perspective. Hazards encountered included dangerous wildlife (e.g., alligators and poisonous snakes); lightning storms; a variety of insects (e.g., mosquitoes, deer flies, horse flies, ticks, and chiggers); sharp sawgrass which could cut like a razor, adding to the potential for BBP exposure; jagged pieces of aircraft wreckage buried in the mud and muck; deep muck or water not readily discernible to an individual; heat and humidity (sometimes in excess of 90°F and 85%); aircraft fluids (e.g., Jet-A fuel, hydraulic fluid) floating in the water; and lastly, emotional fatigue from observing the massive destruction and dealing with a difficult environment.

At all three accident sites, total destruction of the aircraft occurred. A comprehensive bloodborne pathogen awareness and protection program needed to be implemented quickly. FAA and NTSB personnel participating in the investigation were briefed prior to entry into the accident site. In addition, briefings were also given to all other individuals who might need to access the sites; these included recovery teams, individuals who were a party to the investigation (i.e., manufacturers of the aircraft, engines and other components, airline representatives, labor representatives, insurance companies, etc.), law enforcement officers, and medical personnel. The content of these briefings included the dangers of biohazards exposure as specified in the OSHA rule, and concerns with dehydration and fatigue. In addition, due to the inhospitable environment at the ValuJet site, briefings were provided on the dangerous wildlife, lightning storms, personal medical problems that may preclude entry into the accident scene, dehydration, and fatigue.

At all these sites, provisions had to be made for processing biologically contaminated waste generated as a result of the investigation and the BBP requirements. Civilian contractors were brought in to provide these services; however, at the ValuJet site, these services were initially provided by the U.S. Air Force Reserve's 482 Fighter Wing Nuclear, Biological, and Chemical Warfare Decontamination Team. This accident site represented the team's first activation in response to a civilian disaster. The team was in place quickly; therefore, as the full recovery process began, excellent BBP protection services were fully in place. Decontamination stations, waste water containment ponds, biohazard waste disposal services, medical services, and a host of other biohazard precaution functions were set up at the remote site. Eventually, the Air Force Reserve turned these duties over to a civilian contractor.

The OSHA rule mandates restricted access to a biohazard site. To help with this function and with overall security, the local police were used to prevent unauthorized access to the accident sites. In addition, they ensured that all recovery personnel were properly attired in BBP protective gear before being allowed entry to the contaminated site. Access to the USAir site was difficult to enforce because the terrain was hilly and heavily wooded. Therefore, it was possible for unauthorized persons to approach the site wearing BBP attire without being detected and then mingle with the accident investigators. A news reporter, did in fact, enter the crash site and obtained clandestine video using a concealed camera. The terrain surrounding the Roselawn site was flat and without trees, permitting the entire site to be viewed from any one point. Site security was much easier to enforce, and there were no unauthorized intrusions. Access to the ValuJet site was difficult simply by its location; however, to further ensure restricted access, transportation to and from the accident site was limited to specific airboats, boats, and helicopters. The perimeter of the accident site was protected by the Metro Dade County Police. Armed Florida Fish and Wildlife officers in airboats were also used to protect recovery personnel from the dangerous wildlife.

Access to the morgues at the USAir and American Eagle accident sites were controlled by National Guard units. The morgue in Pittsburgh was established at a National Guard base co-located at the Pittsburgh airport; the morgue at the Roselawn accident was located some distance away at an Indiana National Guard armory. The Guard unit at Pittsburgh provided security, but the troops assigned were non-medical personnel. Unfortunately, they did not always ensure that individuals entering and exiting the morgue were properly attired or that they disposed of contaminated BBP equipment properly. National Guard troops assigned to provide security at the Roselawn morgue included medical personnel who were aware of the OSHA BBP requirements and who were very effective in enforcing the requirements.

A three-stage decontamination station¹ was available at the Pittsburgh accident site, with staff available to help cut away used BBP protection gear from the investigators as they left the site and to wash down their boots. Unfortunately, the station was located beyond the accident site perimeter. As a result, to get to the decontamination station, accident investigators were required to leave the contaminated scene and walk through an "uncontaminated" area where workers who were not wearing BBP protection gear were present. This provided a valuable lesson for the future design of support services in placing the decontamination stations at a point where investigators exit the biologically contaminated accident scene.

At Roselawn, a two-stage decontamination station² was placed at the exit point from the accident site. This eliminated the need for the investigators to leave the accident site perimeter to reach the decontamination station. Unfortunately, there were no personnel available to cut away the BBP protection gear from the investigators leaving the site. Although the FAA BBP training sessions instruct investigators in the proper procedures for donning and removing BBP protection gear without assistance, assistance expedited the process. It became common practice for investigators to assist each other in donning and removing PPE, or for other personnel to aid investigators who were entering or departing the scene. The lack of specifically

designated staff to assist in these tasks became an issue, primarily when exiting the scene, because of the increased potential for self-contamination during removal of PPE and the possibility of improper disposal of contaminated gear.

Another issue that had to be addressed at all three sites was the location of latrines. At all three accident sites, they were properly located outside of the perimeter; however, access problems varied and were further complicated by the PPE. At the American Eagle and ValuJet sites, investigators were required to discard their BBP PPE and go through the decontamination station as they exited the site to use the latrines; to re-enter the site they had to draw new personal protective equipment. At the USAir site, however, this was not enforced and investigators often left the site to use the latrine and then re-entered the site without discarding their contaminated BBP protective equipment or going through decontamination. A lesson learned was to recommend that latrines be located just outside the accident perimeter and that investigators be required to discard contaminated protective equipment, go through the decontamination station, and don new protective equipment before re-entering the accident site.

In addition to physically securing the accident sites and providing personnel biological decontamination services, specific personal measures were taken to ensure the safety of all individuals needing to enter the sites. The following precautions were observed to minimize BBP and health risks:

1. Adequate immunization against tetanus and a recent booster were made mandatory.
2. Hepatitis B immunizations were made readily available to personnel; most of the personnel entering the sites chose to be immunized against hepatitis B.
3. Use of contact lenses was forbidden due to increased risk for eye infections.
4. Persons with skin conditions that interrupted the integrity of the skin (e.g., psoriasis, open sores, cuts, burns, skin lesions) were advised against entering the accident site.
5. Persons with eye or ear infections were advised against entering the accident site.

¹ Consists of 3 containers for disinfection; first container has a bleach solution and 2 separate containers for rinsing.

² Consists of 2 containers for disinfection; one with a bleach solution and the other for rinsing.

6. Any leakage of protective clothing was dealt with as soon as possible to prevent contamination.
7. If contaminated water, dirt, or mud entered the mouth, eyes, or ears, individuals so affected were requested to leave the area immediately, and report to medical personnel for examination and irrigation of the affected area with clean water.
8. Briefings were given on BBP hazards, universal precautions, and preventive measures.
9. At the ValuJet site, persons at greater risk for infection were not exposed to water and muck from the accident site; possible conditions included diabetes mellitus, those with concomitant infections or any other underlying condition likely to encourage infection due to lowered immunological defenses.(12)

In spite of these measures, ten documented potential exposure incidents occurred at these three accident sites; however, to date, no known disease has resulted from any of these potential exposure incidents. Given the magnitude of destruction and hazards at the sites and the number of people involved in the investigations, the 10 cases represent a small number. There were four potential exposures during the USAir Flight 427 investigation. All involved non-government employees who received lacerations while working with aircraft wreckage. None of the investigators had previously received the hepatitis B vaccination series; all were given appropriate first aid on scene, removed from the accident site, and referred through their companies for medical treatment. Each individual underwent the OSHA-required post-exposure medical evaluation and follow-up for potential bloodborne pathogen exposure, and eventually received hepatitis B immune globulin and tetanus boosters. Five documented cases of potential exposures occurred as a result of the American Eagle Roselawn investigation. A county coroner worker fell into the water-filled crater created by the main wreckage; the remaining cases were puncture wounds, lacerations, and the contamination of a pre-existing sutured wound. All received appropriate first aid on scene, were removed from the accident site and underwent the OSHA requirements following potential bloodborne pathogen exposure. Only one documented potential

exposure incident occurred during the ValuJet Flight 592 recovery process. That exposure occurred at a place somewhat removed from the actual accident site, and involved a small laceration on a finger of a Federal employee who had elected not to receive the hepatitis B immunization. He was removed from the site and underwent the OSHA required post-exposure medical evaluation and follow-up for potential bloodborne pathogen exposure.

As a related historical note, the Office of Aviation Medicine is aware of one documented case several years ago of hepatitis C (classified, at that time, as hepatitis "non A-non B") in an NTSB investigator, who later became an FAA employee, and which occurred after exposure to blood at a fatal aircraft accident site.(13) Anecdotes have been received of other disease processes acquired at accident sites prior to the OSHA BBP rule, but on further review, confirmation has not been possible.

CONCLUSION

A large aggregate of field experience has been built from past accidents. The key element that has ensured the success of the FAA's Bloodborne Pathogen Program has been training and preparation, not only on the part of the agency, but with the significant cooperation and support of the NTSB. The on-site creation of an extensive support system can only occur if prior planning has been undertaken. A series of proactive steps can be taken to ensure a smooth deployment reference BBP issues when called upon to respond to an aviation disaster. Strategic planning includes:

1. Ensuring that all potential accident investigators are knowledgeable concerning BBP issues and preventive measures, and have received hepatitis B vaccination, if they so desire. Although not from the standpoint of an OSHA BBP requirement, consideration should be given for hepatitis A immunization if accident investigators, in the course of their work, will be involved in travel to foreign destinations where sanitary practices make the possibility of hepatitis A infection likely.

2. Prior identification of companies that can supply large volumes of personal protective equipment (suits, gloves, boots, goggles, etc.) on short notice. This precludes having a large supply on hand, yet ensures rapid availability. These companies should be able to provide a constant supply of PPE, irrespective of the season. Summer or winter will tend to increase the number of some PPE needed because personnel will have more frequent rest periods and will have to discard some items each time.
3. The logistics of providing medical support services. Rest and cool-down facilities must be established for heat casualties. These must be convenient to the accident site and, depending on the site and time of the year, should be equipped to handle a potentially significant number of heat exhaustion cases. In addition, a physician or other clinical provider should be available, either on site or by phone/radio, to provide advice on a variety of problems and questions that may arise.
4. The logistics of providing sufficient quantities of drinking fluids to combat the increased dehydration and heat stress imposed by the use of impermeable gowns. This is above and beyond the basic logistics of supplying on site food and water to meet the normal personnel demands.
5. Development of a network of local assets to provide biological decontamination services for aircraft parts, site evidence, and personnel decontamination. Local assets that can assist or provide such services include coroner and medical examiner offices, fire departments, commercial enterprises, and military units.
6. Development of critical incident stress debriefing teams or availability of Employee Assistance Program (EAP) counseling services to deal with the after-effects of victim recovery and working at the accident site.
7. Determination of work schedules and number of personnel available to work a site based on seasonal considerations. Extremes in temperature will require more personnel, due to a greater number of rest periods and higher potential for incapacitations among the investigators. Provisions must be made ahead of time that ensure adequate personnel resources.
8. Describing the physical layout of support services at an accident site. This description can be drawn from military and prior accident site models and, as a minimum, should include food services, medical services, rest areas, lavatory/latrine location, temporary morgue location, controlled site entry and exit points, and the location for decontamination of wreckage removed from accident site. The placement of these support sites/structures should be done so as to eliminate sources of biological contamination outside of the immediate accident site.

These and subsequent accident investigations have made it quite clear that the FAA's Bloodborne Pathogens Program has accomplished its objectives: to provide those agency employees involved in aircraft accident investigation the necessary knowledge and tools to protect themselves in a biologically contaminated environment. The agency's commitment to ensuring compliance with OSHA standards has minimized potential exposure incidents and prevented any bloodborne disease from being transmitted to investigators since the inception of the program.

Attention still needs to be given to those individuals who are not NTSB or FAA employees and who do not yet fall under a formal BBP training program. Civilian employers must coordinate OSHA BBP training, hepatitis B immunization, medical and training recordkeeping, and pre-issuance of PPE to prepare these individuals for the hazardous environment they will encounter at an accident site. Some of these individuals, to name a few, include representatives of the various manufacturers of aircraft and aircraft components/systems, airline or other commercial representatives, and insurance underwriters. Although infrequent, given the volume of aviation activity that occurs on a daily basis, accidents where biological contamination occurs are an inevitable part of aviation and the investigation of one must be quick, decisive, and thorough with the safety of the investigators assured. The best time to prepare an effective BBP protection program is before an accident occurs.

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